Standards Based Collaboration

Allowing better utilization of existing client applications

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Abstract

The military has invested millions of dollar in collaborative technologies to facilitate faster planning, better situation awareness and more seamless coordination among dispersed forces. Despite this investment there has been little reduction in the size of fleet staffs and the actual impact of collaboration on the conduct of military operations has proved hard to measure. There are a number of problems that keep the military from enjoying the full benefit from the collaborative information environment. These problems include not using industry standards to permit interaction among vender specific synchronous collaborative tools. This paper will focus on improving collaboration among operational forces by using established standards to interconnect collaboration client endpoints. These endpoints include tool suites such as Lotus SameTime, DCTS (Defense Collaborative Tool Suite), H323 endpoints (NetMeeting), and CISCO IP Phones. Without standards based tool suites the information flow within the military will continue to be hampered by vendor specific collaboration stovepipes. The findings in this paper are based on observations and analysis from Fleet Battle Experiments and Limited Objective Experiments conducted by the Navy Warfare Develop Command (NWDC).

Introduction

Collaborative tools can be divided into two major groupings, asynchronous and synchronous. Asynchronous tools allow collaboration between groups where participants are not aware of when other participants will be engaged. Email, newsgroups and web portals are examples of asynchronous collaborative tools. Synchronous tools allow collaboration between groups by participants being engaged simultaneously. . Examples of synchronous tools include instant messaging, video teleconferencing, application sharing (collaborative document development), whiteboard, and text based chat.

The types of collaborative tools employed will largely depend on the mission and infrastructure available to the organization. If the mission is long range planning among action officers much of the interaction will involve email, web portal and document management tools. If the mission is the execution of plans, collaborative tools that permit voice over IP, video and document sharing may be more appropriate. At some point the long range planners need to turn the plans over to the executers. The people executing the plan will have questions and need to coordinate and collaborate with the planners. With

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the two organizations using different collaborative tools there needs to be common standards to allow these two groups to share information.

In the area of asynchronous collaboration the standards are well understood and vendors adhere to those standard. This allows a user on Lotus Notes to send an email to a Microsoft Outlook user, using the SMTP standard. Web browsers can open pages built on HTML and XML standards originating from a multitude of source types.

Although synchronous collaboration has similar standards (SIP Session Initiation Protocol, H.323, T.120, XMPP (Extensible Messaging and Presence Protocol), the standards are continually being defined. Liberal adherence to these standards can cause interaction between the tools to be problematic. Most of the more sophisticated tools like InfoWorkSpace (IWS), IP Phone systems, Lotus SameTime and First Virtual's Click to Meet (CTM) have a proprietary collaboration standard as well as the ability to communicate using accepted H.323, XMPP, and/or SIP standards. Even with these established standards interoperability is not a given. Until synchronous collaboration standards are followed and implemented, like SMTP, interoperability will be limited to the venders' implementation of standards. The implementation of standards in many cases is inadequate for the required collaboration tools and services now being used.

The search for a single tool that fulfills all collaboration requirements has led the military to jump at each new technology in the hope of finally finding the perfect collaboration tools. The problem is exasperated by the limited bandwidth available to afloat and forward deployed forces and different functions each groups needs the tools to perform. There are many reasons why moving towards a Department of Defense (DOD) wide accepted standard would be beneficial. These reasons include;

- Preserve the investment services have already made in collaborative technology
- Allow staff members to join conference on different collaboration servers through a single endpoint client
- Allow services to use specific endpoint tools optimized to operate in a limited bandwidth environment
- Allow services to use tools with special functionality not needed by other services. Allow the employment of client tools with a simplified interface for infrequent users.
- Allow endpoint to endpoint awareness and collaboration

This paper will focus on using standards to allow the interconnection of collaborative endpoints (IP Phones, Room VTC, Desktop Collaboration tools) from different venders to address the six reasons listed above. Desktop collaboration tools are those that provide team rooms, applications sharing, audio/ video conferencing and whiteboard. Using standards allows sharing of information and services between vendor tool sets and allows each functional group (planning, logistics, operations) to use tools best suited for their purposes and still join planning sessions and exchange information with other participants.

Experiment Design

Synchronous and Asynchronous collaboration among operational forces has been a central focus of Fleet Battle Experiments (FBEs) and Limited Objective Experiments (LOEs) at the NWDC since its inception in 1998. During these experiments an increasingly complex suite of collaborative tools have been introduced to fleet users and allowed the tools to play a more critical role in staff operations. During early FBEs IRC (Internet Relay Chat) was used as a better way to coordinate operations among dispersed forces and a web site was stood up to allow information producers to quickly post daily products. Later experiments focused more on email architectures, web portals, document management, synchronous data collaboration, and voice over IP. During the most recent experiments, Millennium Challenge 02, the Split Staff LOE and the Joint Forces Command (JFCOM) Collaborative Information Environment (CIE) LOE, the collaboration experimentation focused on the employment and integration of synchronous collaborative tool suits like IWS and DCTS. These tools provided significant functionality like voice over IP, video, applications sharing, whiteboards, and shared views. These experiments used collaborative tools to support, for example, planning and execution at the Joint Forces Maritime Component Commander (JFMCC) level and the coordination between the JFMCC and the Joint Task Force (JTF) commander. Collaborative interoperability work was accomplished allowing different collaborative devices to pass information using established standards, during the Split Staff LOE and the CIE LOE.

Even though the experimentation focus was on the operational processes there was much useful information gained about the problems associated with the employment of collaborative tools. The Information and Knowledge Assurance (IKA) initiatives, within the larger experiment, focused on the Collaborative Information Environment. The finding from collaborative tool experimentation made the importance of implementing a standards based collaborative environment very clear. Experimentation highlighted the technical issues associated with allowing different collaborative tools to exchanged information with dissimilar endpoint devices. Specifically experimentation focused on allowing desktop collaborative tools, IP phones and room VTC to join into a conferences hosted on DCTS's First Virtual Conference Server MCU (Multi-point Control Unit) and share resources. The resources shared were dependant on the client but generally included audio and video.

Tool and network analysis is difficult on operational networks because there are too many uncontrolled variables. Much of this analysis is subjective because the evaluation involves user's opinions of how well the tool supported the mission. Surrogate networks emulating operational networks without all the wildcards have been constructed in order to provide some quantitative analysis. During the CIE LOE NetFlow monitoring equipment was set up to allow detailed recording of each tool's bandwidth consumption. While this information was not critical to understanding standards based collaboration it did help in understand which collaborative client operated most efficiently in a bandwidth constrained environment.

The collaborative tool experimentation took place in three environments. Some experimentation was conducted on fleet secret network (Secret Internet Protocol Router Network SIPRNET), other tests occurred in enclaves with access to SIPRNET and other

testing was done in the lab on closed networks. The focus of NWDC's experimentation is on the fleet and the application of new concepts, procedures and technologies to fleet operations. Therefore, whenever possible NWDC seeks to operate on actual fleet communications networks. When working in the lab environment satellite emulators were used to impair bandwidth by introducing bottlenecks, latency, and an error rate that could be expected in the fleet.

Findings/ Discussion

The problem of interoperability among collaboration tools has become more acute recently as the deployment of synchronous collaborative tools has dramatically increased. Each service, and some cases specialized components of services, have purchased different tools and when these forces come together to conduct Joint Task Force Operations the results are islands of collaboration that don't interact effectively. Despite much discussion on a common collaboration standard, no agreement on a standard, that will allow interoperability at the client level, has been reached. The inability to settle on a single collaborative tool or a single standard has resulted in stovepipes of collaboration that hamper coordination between and within services. The reasons for the multiple collaborative tools include:

- Services have already invested in tools and their limited financial resources will not allow complete replacement of existing systems.
- Current software provides unique functionality not available in other collaborative tools.
- Current collaborative system works in a bandwidth constrained environment.
- Training requirements for both operators and technicians make changing to a new collaborative tools suite difficult.
- New tools are released so frequently that any product chosen might be out dated within a year.
- Operational staffs have little control over the collaborative software they are expected to use.
- Different governing organizations are dictating different products and no organization is providing all the resources to purchase, install, and train users on the new tools being mandated.
- Some of the tools being mandated have antiqued user interfaces and limited functionality. Users are frustrated by the disparity between the tools available commercially and what is approved for military use.
- Early experiences with robust collaboration suites were disappointing and staffs are reluctant to repeat the experience.

For the reasons listed above its unlikely the military will be able to agree on and purchase a single vendor's tools. Linking together disparate collaborative tools through accepted standards provides the most viable solution to the growing numbers of collaborative tool stovepipes. If all the tools, being installed in the fleet, adhered to accepted standards each

service or military unit could continue to use the collaborative tools they were trained on and still interact with other units using different tools.

During laboratory testing, for the C2F Split Staff LOE and the CIE LOE, NWDC experimented with four tool suites. These suites are IWS, DCTS, Lotus SameTime, and FVC Click to Meet Express.

Synchronous collaborative tools employ two methods of transferring UDP (User Datagram Protocol) traffic voice and video). These two transmission methods are unicast and multicast. These two methods can be combined to produce three options for voice, video and data transmission, which are unicast, multicast and IP multicast between MCUs. Multicast has some significant advantages in term of bandwidth efficiency over unicast however multicast is not used in fleet communications today because of the need for special network routers and the danger of multicast traffic flooding the network. There are two multicast modes sparse and dense. Dense mode will broadcast the packets to all multicast enabled routers while sparse mode will only transmit packets to where there are requesting endpoints. With unicast there are n transmissions to n clients, i.e. for 30 clients 30 transmission streams are needed. See Figure 1. With multicast there is 1 transmission for n clients i.e. 1 transmission for 30 clients See Figure 2. The network routers in multicast transmit the packets to what is called a multicast group. The clients interested in the packets would then subscribe to the group, similar to how a radio and TV stations work. Multicast can be applied to a multi MCU architecture, where one transmission could be transmitted to multiple MCUs.

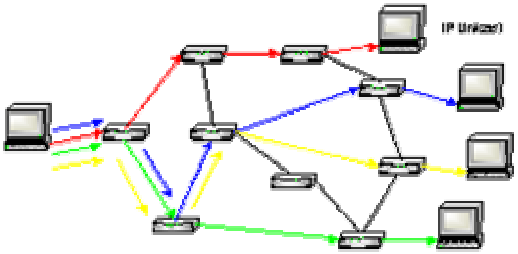

Figure 1 IP Unicast

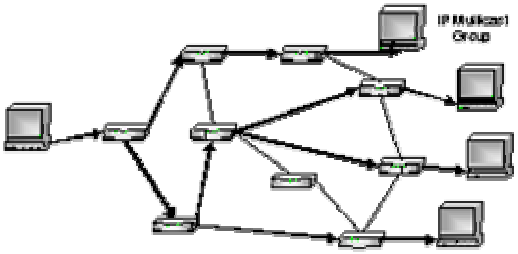

Figure 2 IP Multicast

With the H.323 standard there are four different functional units that comprise a H.323 network. These units are Gatekeepers, MCU, Gateways and endpoints. Gatekeepers ensure calls are routed across the network; they control end point access to network resources, monitor service usage, and perform control and management functions necessary for the integrity of the system. The MCU supports multi-party conferences between multiple locations in both a centralized and decentralized MCU architecture. The gateways are used to translate between protocols and for connecting IP based voice and video and the Public Switched Networks (PSTN). Finally the endpoints are end user devices such as the NetMeeting, Vigo, Tandberg Room VTC, and IP telephones. Different vendors commonly produced these devises, which adds to the complexity. In a standards based collaborative environment, where an ad hoc team of forces has been brought together to support a JTF, it is very likely that all the pieces of the H.323 network will be from different vendors. Having multiple MCUs and endpoints from different vendors collaborating across a standard's based network is very difficult but absolutely needed based on the diversity across the DOD.

The other standard often referred to is T.120. T.120 architecture is actually a family of protocols the cover the multi-user sharing of data. The T.122, T.123, T.124 and T.125 make up the networking level of the T.120 standard. The applications standards are T.125, T.127 and T.128. The T.125 is the multi-user whiteboard function. The T.127 is the file transfer standard and T.128 is the program sharing standard. Data interoperability between T.120 clients has not yet been the focus of extensive testing. There was little success with the testing performed.

During laboratory events and LOEs the tools interoperability was tested based on the H.323 and T.120 standards. The tests can be grouped into 3 major categories; endpoint to endpoint, endpoint to MCU, MCU to MCU. In this paper the term MCU is used to refer to both MCUs and conferencing servers since most collaboration suites contain much more functionality than is required by the H.323 MCU standard. Despite the multitude of capabilities in a collaboration suite, the initial testing focused on sharing audio and video between collaboration suites and endpoints. Devices used during the tests were:

- Endpoints: NetMeeting, Vigo, Cisco IP phone, Tandberg 8080, Nortel IP phone; Collaboration Suites: InfoWorkSpace (IWS) 2.5.1, Lotus SameTime 2.5; First Virtual Click to Meet Express 2.0;
- MCUs: Cisco IP/VC 3540, FV Conference Server 6.0 and 7.0;
- Gateways: Cisco Call Manager 3.3.3, Lotus Sametime 2.5, FV Conference Server 6.0 and 7.0;
- Gatekeepers: Cisco MCM (Multi Media Conference Manager), FV Conference Server 6.0 and 7.0, Microsoft ISA.

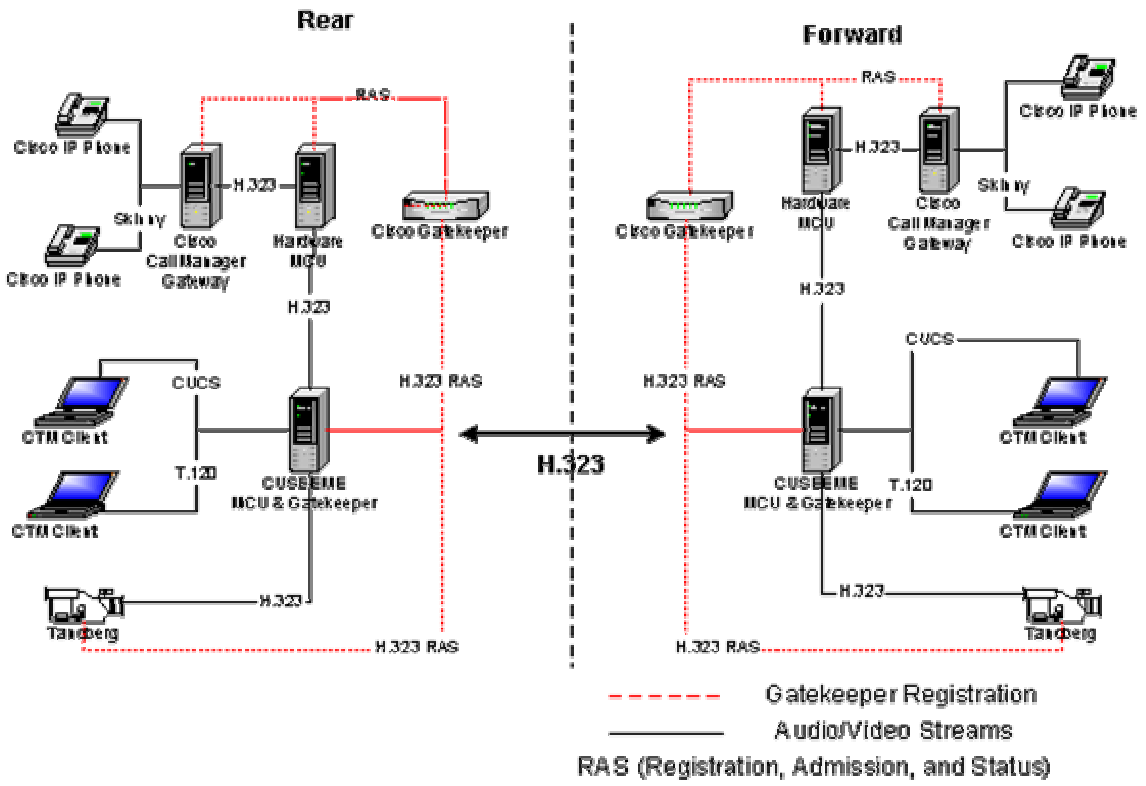

Figure 3 Multiple Endpoint, MCU, and Gatekeeper Architecture

The specific standards based collaboration tests conducted were:

1. **Endpoint to Endpoint:** Several lab tests were conducted verifying connectivity between H.323 endpoints. A Cisco gatekeeper provided the dial plan. All endpoints were able to conduct audio sessions and all video enabled endpoints were able to receive and transmit video. The H.323 end points tested included NetMeeting, VIGO VTC and Tandburg VTC. IWS, Click to Meet, and SameTime clients are not H.323 endpoints thus they can only participate in collaborative sessions with their respective servers.
2. **Endpoint to MCU/Conference Server:** H.323 MCUs are designed to work with all H.323 endpoints. Conference Servers are primarily designed to interact with their clients first and then if a H.323 gateway is provided a H.323 endpoint may participate in a conference. The following tests determined the level of interoperability of conference servers with other H.323 endpoints.
    a. **Cisco 3540 MCU:** The Cisco MCU successfully conducted audio and video session with all H.323 endpoints. The Cisco gatekeeper was used to provide a dial plan for all H.323 endpoints to enter conference. Data collaboration (T.120) was not available for these tests because the Cisco T.120 module was not available.

b. **FV Conference Server 7.0:** The FV conference server successfully conducted audio, video, and data (T.120) sessions with capable H.323 endpoints. The CTM (Click to Meet) express client uses an http control capability for presentations. This feature was not available to endpoints because it is not part of the T.120 protocol. All endpoints registered to the FV Conference Server's gatekeeper.

c. **Lotus SameTime 2.5:** The SameTime H.323 gateway did not work consistently with all endpoints. When the SameTime server was registered to the Cisco gatekeeper Cisco IP phone establishing a session with a SameTime conference was sporadic. NetMeeting would establish connection and then drop out. Although SameTime has an H.323 gateway it is not a true MCU. This may have played a part with the endpoint connectivity issues. In order to establish a more detail case as to why the endpoints didn't work, vendor support will be needed.

d. **InfoWorkSpace:** Out of all the collaboration suites tested IWS was the only one without a H.323 gateway. Without a gateway the only client IWS can work with is its own client

3. **MCU/Conference Server to MCU/Conference Server:**

   a. **Cisco MCU to FV Conference Server 7.0:** The two MCUs were connected, but they were not truly cascaded. They were able to share audio and video. The connection was established by inviting the FV conference from the Cisco MCU. T.120 did not work because it was not part of the Cisco MCU.

   b. **Cisco MCU to Lotus SameTime 2.5:** The two MCUs were connected, but they were not truly cascaded. They were able to share audio but the video worked only in one direction. The connection was established by inviting the SameTime conference from the Cisco MCU. T.120 did not work because it was not part of the Cisco MCU.

   c. **FV Conference Server 7.0 to Lotus SameTime 2.5:** The collaborative suites used were SameTime 2.5 and CTM Express 2.0 pointing to a FV Conference Server. A CISCO MCU was used to invite a conference on the Same Time Server and a conference on FV conferencing server into a conference on the CISCO MCU. With this configuration the two desktop collaborative tools were able to conduct audio collaboration. Video was attempted but was unidirectional. T.120 was not possible because it was not part of the Cisco MCU.

The primary findings are H.323 audio worked in most cases but video was far more problematic. The T.120 only worked from MCU to endpoint. Therefore even though NetMeeting, FV Click to Meet and Lotus SameTime are all H.323 and T.120 compatible only limited audio interoperability was achieved. The T.120 module for the Cisco MCU may solve these problems. More effort is needed to get data collaboration working between MCUs or collaboration suites.

The standards issue is further complicated by discussions over what standard to adopt. With voice and video over IP the discussion has resolved around whether to stay with the

International Telecommunications Union (ITU) blessed H.323 standard or adopt new standards SIP and XMPP, which is backed by a growing number of equipment and service providers. While it appears H.323 still has favor in the DOD, there is no guarantee that H.323 will still be the standard of choice for packet based multimedia communications in the future. The DISA sponsored Collaboration Interoperability Working Group (CIWG) meets on a regular basis to discuss DOD collaboration. XMPP and SIP have been significant topics of conversation of late. Because of XMPP's extensible nature VoIP and whiteboard capabilities can be added to its text messaging and presence protocols. With the cores set of capabilities available in XMPP it becomes a logical choice for DOD collaboration. Even if H.323 does remain the standard there are new versions of the protocol released on a regular bases and application must be continually updated to conform to the latest H.323 version. These updates are necessary to integrate new features and to eliminate security holes in previously released standards. While these continual updates are expensive for developers and inconvenient for users they are necessary and there are real benefits in having tools conform to the latest standards. These standards are often complex and leave a great deal of room for interpretation. With the H.323 standard alone version 4 is the latest release yet most tools in use comply with version 2 or 3.

Vendors build tools that will provide the greatest functionality to their users. Exact adherence to standards is not a problem users are likely to notice when viewing a tool's functionality. More importantly vendors make money by selling more licenses not by protecting the user's current investment. In some cases the proprietary features a collaborative tool provides are the most capable component of the tool suite. Therefore users may have to accept less functionality in order to get fuller compliance with standards. The buyer will need to enforce interoperability standards by only buying software that is truly interoperable.

The term interoperability has been used liberally to describe the ability to exchange information between collaborative systems. The problem is collaborative tool suites like DCTS and Lotus SameTime are complicated and contain multiple components. Even though both tools are built to H.323 and T.120 standards the two tool suites are only able to exchange audio and that exchange happens through the CISCO MCU. The interoperability problem gets even more difficult with tools like IWS that are built to proprietary standards. With tools built to proprietary standards interoperability only happens when translators (gateways) are installed between the two systems. Some manufactures like CISCO that use proprietary standards, include translators in their gateways to allow interaction with other widely accepted protocols. For tools like IWS with limited installation base the translation tools do not exist.

Within the military, organizations exist to test collaborative tools to assure conformance to accepted interoperability standards. The Joint Interoperability Test Center (JITC) is one such organization. JITC has defined three levels of certification: system, component, and enhancement. The enhancement certification has two major criteria, presence awareness and the ability of the clients to coexistence on a common workstation. Because JITC has defined three levels of certification, tools certified as enhancements (IWS) are not 100% interoperable. The IWS client cannot participate in audio, video, or data

collaboration with out launching a certified component such as NetMeeting. This presents some confusion as to the meaning of being JITC interoperable certified.

In industry many products advertise compliance with standards but in reality these products are only partially compliant. That means only a few features of the many offered by the vendor are actually built to be compliant with H.323 or T.120 standards. With the loose interpretation of the standards even if two vendors built a tool function to be compliant with standards it is still possible the two tools will not interoperate fully. Many synchronous collaboration vendors make their tools proprietary in order to protect their investments.

The ability of tools to interoperate must be addressed at several layers to provide the functionality users need. These layers include:

- Authentication of users entering the session
- Dialing plan, especially in a multiple MCU environment (ability to establish sessions with remote users)
- Awareness of connected users and virtual locations
- Support multiple Audio and Video codecs and protocols
- File transfer
- Text chat

The issue of the additional complexity associated with interconnecting collaborative tools based on standards must be addressed. The technician onboard a ship may have problems making single vendor collaborative tools work let alone interconnecting tools from different vendors. For example, with IWS there are no decisions required in terms of audio or video codex because the tool does not support multiple codex (coder decoder). If however FV Click to Meet is being brought into a SameTime environment, issues of audio and video codecs must be considered. Issues of which gatekeeper to use, what addressing scheme will be used and gateways must be considered in a multiple vendor environment as well.

Summary

Standards based interoperability of synchronous collaborative tools presents the most logic path forward for breaking down the stovepipes of collaborative tools that now exist. Because of cost, training and bandwidth issues completely dropping the currently used tools and switching to a single Department of Defense wide tool is not a viable option. During recent laboratory and fleet experimentation the feasibility of connecting collaborative tools based on industry standards was proven viable. There are numerous standards adherence issues that make the integration of different vendor's collaborative tools difficult. The complexity of this integration issue is further complicated by the steady introduction of new standards. The collaborative tools in use today are complicated products with much functionality. In some cases each function in the tool set is support by a different standard. So far audio collaboration has been the most integrated capabilities. The data collaboration has proved to be the most difficult.

Road Ahead

The desired end state, for standards based interoperability among synchronous collaborative tools, is comparable to the interoperability email clients enjoy using the SMTP standard. Before email was standardized interoperability between email systems was difficult. Email interoperability is no longer a consideration. Client interoperability problems were solved by agreeing to client to server standards (POP3, IMAP) and server to server standards (SMTP). Developing agreed upon standards for synchronous collaborative tools has been hard because the functionality of these tools keeps expanding and the tools are much more complex than email. The foundation, for these future standards, exist in the synchronous standards (H.323, T.120, XMPP, SIP) being used today.

Basic synchronous collaboration capabilities should include: VoIP, text chat, white board, application share, http control, and user awareness. Every client should contain these basic capabilities. Collaboration suites could then add any additional functionality to their tool set like Microsoft Exchange has added calendaring and other feature above and beyond the standard email functions. If all tools adhere to these standards it would be possible to find and initiate collaborative sessions with anyone on DOD networks that has a client conforming to these basic capabilities.

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Experiment Background

- Distributed C2 Initiative Areas
  - Collaborative Information Environment (CIE)
  - Agent Based Computing (ABC)
  - Information Management (IM)
  - Cross Domain Solutions (CDS)
  - Advanced Networking
- Events Completed
  - Split Staff Experiment, MNME 03 (C2F, Norfolk)
  - JFCOM CIE LOE (NWDC Lab)
  - Multiple Secure Level Exploration (NWDC Lab)

Abstract

- Several significant problems prevent the military from enjoying the full benefit of collaborative tools. These problems include poorly defined standards and a lack of adherence. These problems are not insurmountable. This paper addresses these problems and describe some solutions tested during limited objective experiments.

Background

- Synchronous focus verses asynchronous
- Military planning focus verse execution
- Overhead associated with toolset
- Operational focus verses tactical or strategic
- Multiple tool integration verses single tool

Experiment Design

- NWDC conducts experimentation at the Operational level
  - Technical exploration secondary
- Collaborative Tools a focus in many Fleet Battle Experiments
  - Systems examined in several venues
- Experiment series tested an increasingly complex suite of tools

Issues preventing agreement on single collaborative system

- Sunk cost
- Unique functionality
- Bandwidth Issues
- Training on yet another system
- Each tools has its own supporters
- Interface preference
- Prior experience (Negative)

Benefits of Standards Based Interoperability

- Reduced Stovepipes
- Reduced training
- Reduced software installation
- Users focused on subject matter not learning new tools

Issues preventing Standards Based Interoperability

- Poorly defined standards
- Vendors not fully implementing standards
- Frequently updated standards
- Potential loss of functionality
- Complexity of solution
- Vendor not motivated to support interoperability

Standards

- H.323
- T.120
  - Network T.122, T.123, T.124
  - Application T.125. T.127, T.128
- SIP (Session Initiation Protocol)
- SIMPLE (SIP Instant Messaging and Presence Leveraging Extensions)
- XMPP (Extensible Messaging and Presence Protocol)
- Proprietary Protocols

H.323 Terminology

- End Points
  - User Interface (NetMeeting, VTC)
- MCUs
  - Support multiple party conferences
- Gateways
  - Translate between protocols, and IP to Public Switched Network
- Gatekeepers
  - Route calls, control access, monitor usage, management functions

Functionality Sought

- Voice over IP (VoIP)
- Text Chat
- Whiteboard
- Application Sharing
- HTTP Control
- User awareness
- Group Work space
- Video
- File Transfer
- Dialing Plan

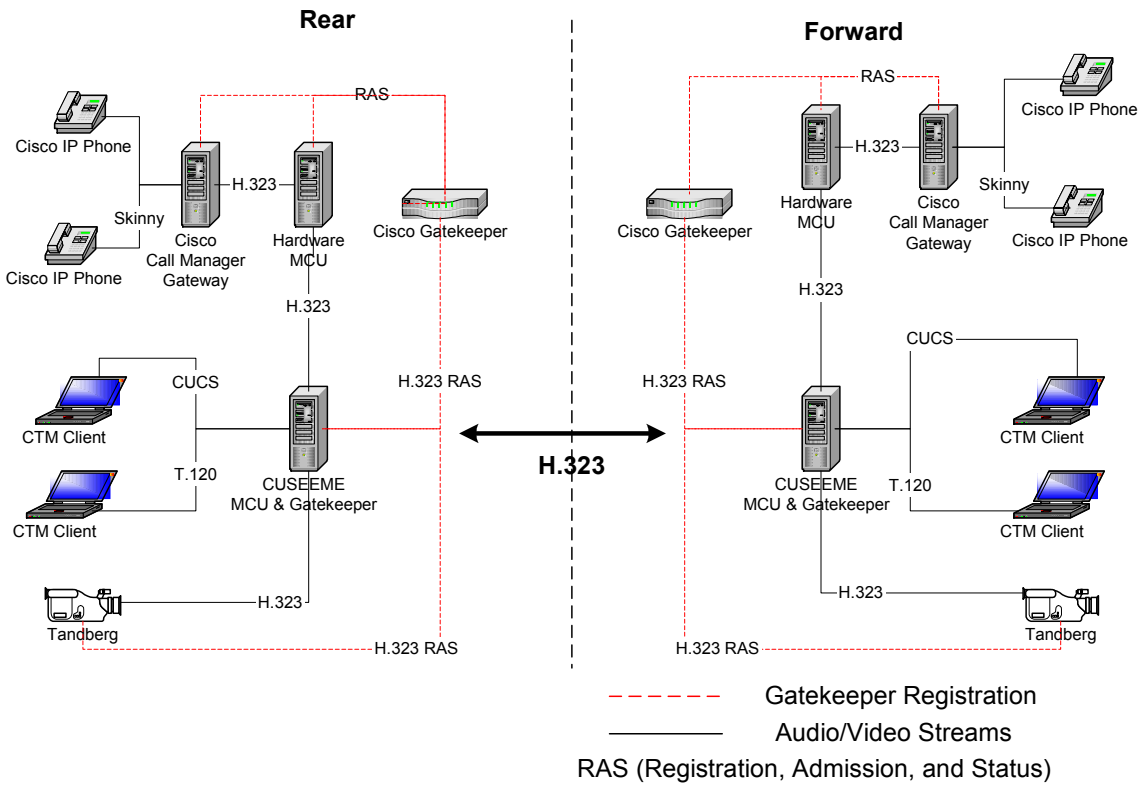
Testing Conducted

- End Point to End Point
  - Fully H.323 compliant NetMeeting, VIGO, Tandberg
- End Point to MCU/ Server
  - Click to Meet to First Virtual Server (FVS), NetMeeting to FVS, CISCO IP Phone to FVS
- Server to Server/ MCU
  - SameTime to FVS
  - SameTime and FVS to CISCO MCU

Interoperability Options

- Any endpoint can talk to any MCU/ Server
- Endpoints into specific servers with servers talking to other severs
- Endpoints into specific servers with servers all talking to third party server which bridges between servers

Sample Multi-Endpoint and Multi-Server Architecture



Interoperability Bottom line

- Audio between different end points using common MCU worked. Used IP phones, VTC, and synchronous collaborative tool suites with First Virtual Server.
- Audio between servers accomplished only through CISCO MCU bridge
- Limited testing done with video between server. One way video only demonstrated
- T.120 interoperability
  - Different end point through common server worked
  - Interoperability a problem between servers; CISCO bridge did not support

Road Ahead

- Continue work on new protocols to understand benefits and costs
- Continue experimentation in bandwidth efficient topologies/ tools.
- Explore information management techniques for afloat environment
- Continue close coordination with JFCOM
- Standards base CIE with Multi-national security domains
- Support future Fleet operational experimentation

Conclusion

The standards exist to connect multiple collaborative tools into a single conference sharing voice, video and data. Employing and interconnecting standards based tools is not easy but the benefit out weigh the costs. Venders must be pushed to make tool fully adhere to agreed upon standards.